Instruction Manual
Models 309, 319A
HIGH VOLTAGE
POWER SUPPLIES

Baird-Atomic, Inc.

33 UNIVERSITY ROAD • CAMBRIDGE 38, MASS.

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NOTE

The specifications in this manual pertain to the instrument as it leaves the factory. There is a jumper soldered across the ripple filter (R14, C7, R15, C8) which may be removed at the customer's discretion in order to reduce further the ripple content of the high voltage (e.g., for accurate proportional counting). The ripple attenuation is then approximately 350:1, or a ripple of less than 1 millivolt. Series resistors R14, R15 limit the available current during this mode of operation.

WARNING

Voltages as high as 8000 volts exist within this equipment. Contact with such voltage may prove fatal. EXTREME CAUTION should be exercised if the high voltage chassis (left side) is operated without its protective cover screen. All high voltage capacitors should be discharged prior to working on the interior parts of this unit.

SECTION I

GENERAL DESCRIPTION

The Models 309 and 319 High Voltage Power Supplies each provide a stabilized d-c voltage which is continuously variable between 1000 and 5000 volts. The models differ primarily in their power requirements. Model 319 requires only 115VAC; Model 309 requires 6.3VAC, 115VAC, and 250VDC (regulated).

Model 309 contains a high voltage chassis (Model 1203A), a high voltage adjustment and metering circuit, an on-off switch, and a pilot lamp. The high voltage chassis consists of a delay circuit to prevent output voltage overshoot when the equipment is turned on, a half-wave rectifier, and an electronic voltage regulator. Model 319 is essentially a Model 309 plus a low voltage chassis which supplies +300V and 6.3VAC to the high voltage chassis. The high voltage chassis (Model 1203) of Model 319 differs from that of Model 309 only in that its plate supply requirements are +300V instead of +250V.

Physically, Models 309 and 319 consist of modular left-side and right-side chassis assemblies and a front panel mounted in a bottom- and top-ventilated cabinet. The left-side chassis is the high voltage chassis in both models. In Model 319, the right-side chassis is the low voltage chassis; in Model 309, the right-side chassis is blank. The front panel carries the voltage indicating meter and all necessary operating controls. Table I lists the principal electrical characteristics for both models.

TABLE I.

OPERATING SPECIFICATIONS

Model 319

Range: 1000 to 5000V, positive output, continuously variable by adjustment of HIGH VOLTAGE COARSE and FINE controls.

Maximum Loads: 600 microamperes at 1000V, 350 microamperes at 3000V, and 100 microamperes at 5000V.

Load Regulation: Output voltage decrease is less than 0.075 percent at 1000V, 0.015 percent at 3000V, and 0.005 percent at 5000V for a 10 percent current increase at maximum load.

Line Regulation: Change in output voltage per volt input voltage change from 105 to 125V is less than 0.018 percent at 1000V, 0.01 percent at 3000V, and 0.0014 percent at 5000V.

Stability: Approximately 0.2-percent output voltage change per day.

Ripple: Less than 0.3V peak-to-peak.

Input Requirements: 105 to 125V, 60 cycles, approximately 60 watts.

Time Delay: To prevent overshoot when turned on.

Model 309

The operating specifications of the Model 309 Power Supply are dependent upon the characteristics of the externally-supplied a-c and d-c voltages. In general, these specifications will be very similar to those of the Model 319 Power Supply except when the external a-c filament voltage is unregulated. In this case the line regulation is somewhat less stable than shown in Table I. Input requirements for the Model 309 Power Supply are: 6.3 VAC at 0.9 ampere, 115VAC at 0.15 ampere and 250VDC (regulated) at 12 milliamperes.

SECTION II

INSTALLATION

Figure 1 provides front panel dimensions to aid in planning an installation. After unpacking, remove the equipment from its cabinet, inspect for shipping damage, and clean out all foreign matter. Both models may be removed from their cabinets and mounted in standard 19-inch relay racks. The power required to energize each model is listed in Table I.

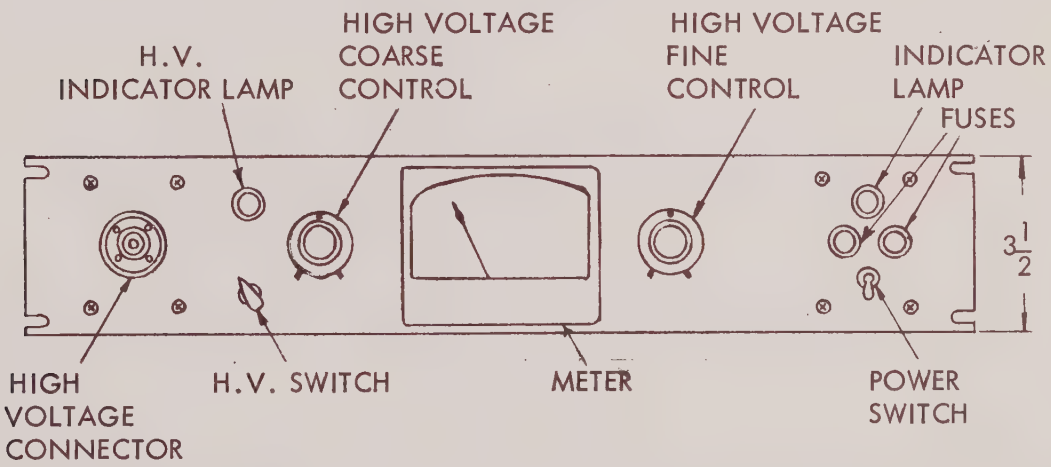


Figure 1. Front Panel, Model 319

SECTION III

OPERATION

3.1 Model 319

a. Turn the POWER switch to ON. The indicator lamp (white) should light.

b. Turn the HIGH VOLTAGE COARSE and HIGH VOLTAGE FINE controls fully counterclockwise.

c. Turn the HIGH VOLTAGE switch to ON. The H. V. indicator lamp (red) should light. Voltage should appear at the HIGH VOLTAGE connector about 30 seconds after closure of the POWER switch.

NOTE

Turning the HIGH VOLTAGE switch to OFF removes voltage from the HIGH VOLTAGE connector and meter circuit without shutting off line power. Thus this control functions as a standby switch.

d. Adjust the HIGH VOLTAGE COARSE and FINE controls for the desired regulated output voltage (between +1000 and +5000V) as indicated by the meter.

3.2 Model 309

Follow steps a, b, c, and d above. The POWER switch of step a is found on the parent instrument which furnishes the externally supplied a-c and d-c voltages. Voltage should appear at the HIGH VOLTAGE connector about 30 seconds after closure of this switch.

SECTION IV

THEORY OF OPERATION

4.1 Model 319

a. High-Voltage Chassis. The high voltage chassis consists of a half-wave voltage doubler rectifier followed by an electronic shunt-type voltage regulating circuit.

The regulating circuit prevents variation of the output voltage when either the line voltage or the load current varies, and it suppresses the ripple content of the d-c voltage at the rectifier output.

When POWER switch S101 is turned ON, the heater of thermal switch V5 is energized. To prevent overshoot of the high voltage, V5 has a delay of 30 seconds before its relay contacts close to excite the primary of step-up transformer T1. In this time, all tubes in the regulating circuit are brought to operating temperature. When sufficient time has elapsed to allow the contacts of thermal switch V5 to close, high-voltage output will still be delayed after turning the HIGH VOLTAGE ON-OFF switch ON by the time required for V1 to reach operating temperature, a period of several seconds at most. During one-half cycle of the input a-c voltage at the secondary of T1, capacitor C1 charges through high voltage selenium rectifiers CR1 and CR2 to a voltage near the peak value of the a-c voltage. On the remaining half cycle, the voltage across C1 is added to the input a-c voltage and a resultant voltage of nearly twice the peak value of input a-c voltage is coverted by high-vacuum rectifier V1 to a pulsating d-c voltage which is developed across storage capacitor C2. This voltage is then stabilized and smoothed by the electronic regulating circuit consisting of tubes V2, V3, and V4.

In the regulator circuit, a fraction of the output voltage, determined by the setting of HIGH VOLTAGE FINE control R8, is compared against a fraction of the reference voltage developed across reference tube V4, determined by the

setting of HIGH VOLTAGE COARSE control R11. Any incremental difference in the two voltages is amplified by differential amplifier V3 and applied to the grid of shunt-regulator tube V2, whose internal impedance is made to vary. The sum of the load current and the anode current of regulator tube V2 flows through resistor R1 in series with rectifier V1. The internal impedance variation of regulator tube V2 controls a part of the current flowing through the series resistor in such a manner that any output voltage variation results in a change in voltage drop across the resistor which opposes the original output voltage variation. Should the output voltage increase slightly, the bias at pin 7 of V3, the comparison amplifier, will become more positive, while the bias at pin 2 of this tube stays fixed at a setting of the HIGH VOLTAGE COARSE control R11. This bias variation is amplified by V3 causing one anode (pin 1) potential to increase. The anode is directly coupled to the grid of regulator tube V2, so that the impedance of V2 will decrease and the increase in anode current through this tube will produce an increase in voltage drop across the series resistor, causing the output voltage to drop. A decrease in output voltage will result in a reverse action. The time lag in action of the feedback system is very small, and the output voltage is held nearly constant despite variations in input voltage and output current. Output voltage variations due to ripple are coupled by C4 to a grid of differential amplifier V3. The feedback loop gain is greater for power line frequencies than for d-c variations so that ripple is greatly suppressed.

Output voltage is indicated by M1, a 50-microampere meter paralleled for calibration purposes by Rx. The filter network consisting of R10 and C6 serves to protect M1 from the damaging effects of a reverse meter circuit current which arises when S1 is turned OFF. Maximum voltage output is determined by calibrating resistor Ry.

b. Low-Voltage Chassis. The low-voltage chassis supplies from 115VAC all operating power requirements of the Model 319. This chassis contains an input-regulating power transformer which stabilizes against line voltage

fluctuations, and a conventional full-wave center-tap rectifier followed by a condenser-input L-C filter. Plate and filament transformer T101 is energized through fuses F101 and F102 when POWER switch S101 is turned ON. This transformer supplies 6.3VAC regulated heater potential to tubes V2, V3 and thermal switch V5.

Capacitor C101 is essential to the regulating action of T101. Rectifier tube V101 supplies pulsating direct current to a smoothing filter consisting of C102, C103, and L101. The regulated +300V output appears across bleeder resistor R101 and supplies plate voltage through HIGH VOLTAGE ON-OFF switch S1 to dual triode V3 of the high-voltage strip.

4.2 Model 309 (See Figure 3.)

Operation of the high voltage chassis of the Model 309 is identical to that for the Model 319 except that the values of R2 and R3 are modified to allow the chassis to operate from an externally supplied +250V instead of the +300V supplied by the low voltage chassis in the Model 319.

SECTION V

MAINTENANCE

Loss of regulating action may require replacement of shunt-regulator tube V2 and/or comparison amplifier V3. All electrical components are identified by symbol numbers in figures 2 and 3 for easy location. These components are described in the Parts List. The appropriate schematic diagrams are included to assist in isolating circuit faults and making repairs.

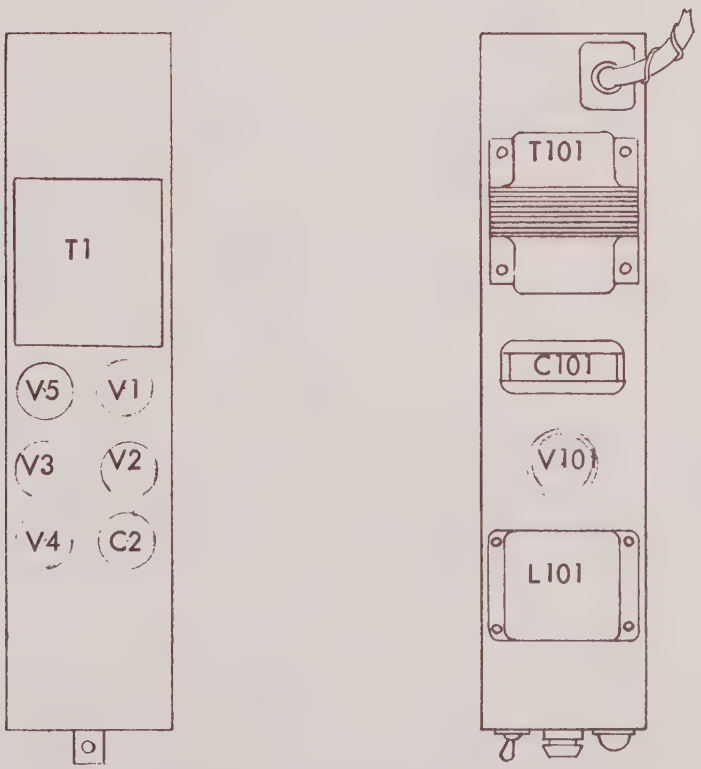


Figure 2. Component Tube Layout

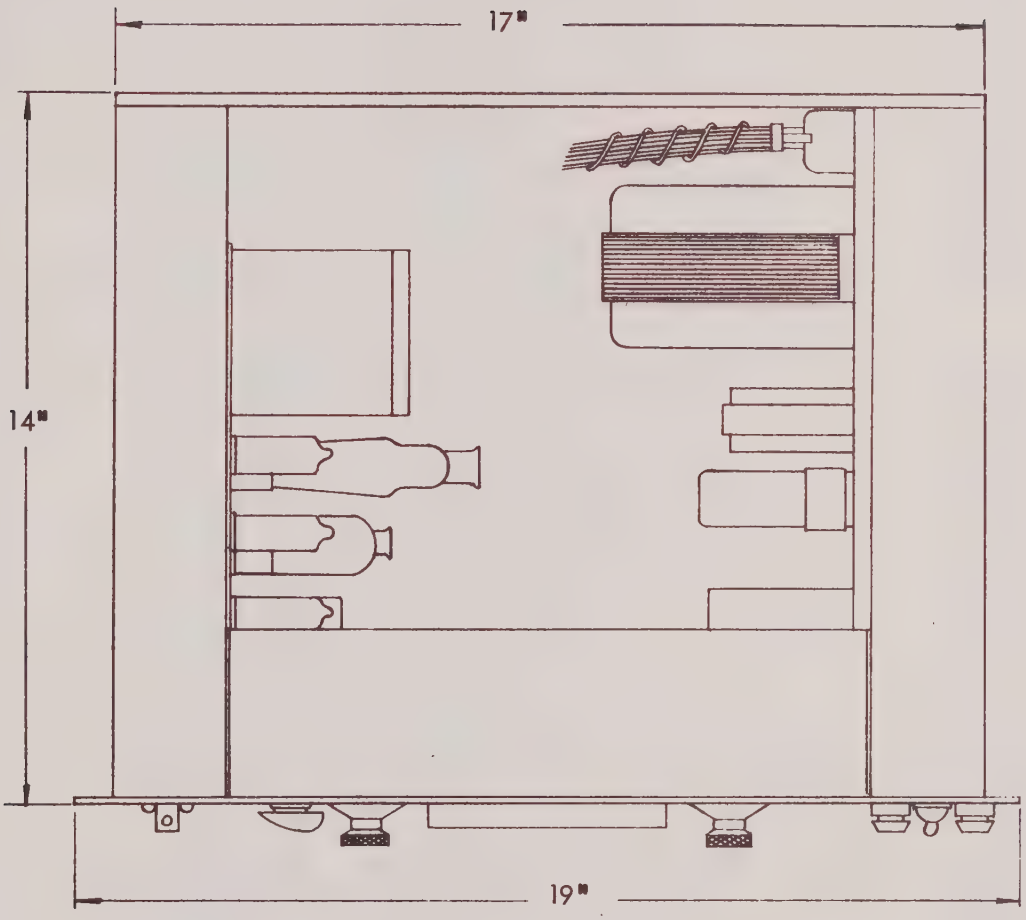


Figure 3. Top View

SECTION VI

PARTS LIST

Symbol Designation	Description	B/A Part No.
C1	CAPACITOR, 0.01μf, 5KV	00551
C2	CAPACITOR, 0.02μf, plastic film, 10KV	00671
C3	CAPACITOR, 10μf, 450V	00525
C4	CAPACITOR, 0.005μf, silicone-filled, 8KV	00744
C5	CAPACITOR, 0.01μf, ceramic disc, 600V	00020
C6	CAPACITOR, 0.47μf, paper, 200V	00734
C7	CAPACITOR, 0.005μf, 8000VDC, Mylar	00744
C8	CAPACITOR, 0.005μf, 8000VDC, Mylar	00744
C101	CAPACITOR, 1μf, oil-filled, 660VAC (supplied with T101)	
C102	CAPACITOR, 4μf, oil-filled, 330VAC	00598
C103	CAPACITOR, 4μf, oil-filled, 330VAC	00718
CR1	RECTIFIER, selenium, HV, 5ma, 1625V	00611
CR2	RECTIFIER, selenium, HV, 5ma, 1625V	00611
F101	FUSE, 3/4 amp, 125V, 3AG, time delay	00713
F102	FUSE, 3/4 amp, 125V, 3AG, time delay	00713
I1	LAMP, NE-51	00854
I101	LAMP, NE-51	00854
J1	CONNECTOR, coaxial, HV	00716
M1	METER, 50μa, 0-5000V full-scale, 1510 ohms	00973
P101	Line cord and plug	00979
R1	RESISTOR, 5 meg, 5%, 10W, film type	00685
R2	RESISTOR, 30K, 5%, 2W, comp.	01039
R3	RESISTOR, 75K, 5%, 2W, comp.	01067
R4	RESISTOR, 18K, 5%, 2W, comp.	01145
R5	RESISTOR, 2.2 meg, 5%, 1/2W, comp.	00243
R6	RESISTOR, 82K, 5%, 1/2W, comp.	00323
R7	RESISTOR, 80 meg, 5%, 2W, film type	00528
R8	RESISTOR, 500K, 10%, 2W, variable	01371
R9	RESISTOR, 600K, 1%, 1/2W, film type	00494
R10	RESISTOR, 770K, 1%, 1/2W, film type	00518
R11	RESISTOR, 100K, 10%, 4W, variable, wire-wound	01084
R12	RESISTOR, 15K, 5%, 1/2W, comp.	00362
R13	RESISTOR, 270K, 5%, 1/2W	00298
R14	RESISTOR, 10 meg, 5%, 1/2W, comp.	00196

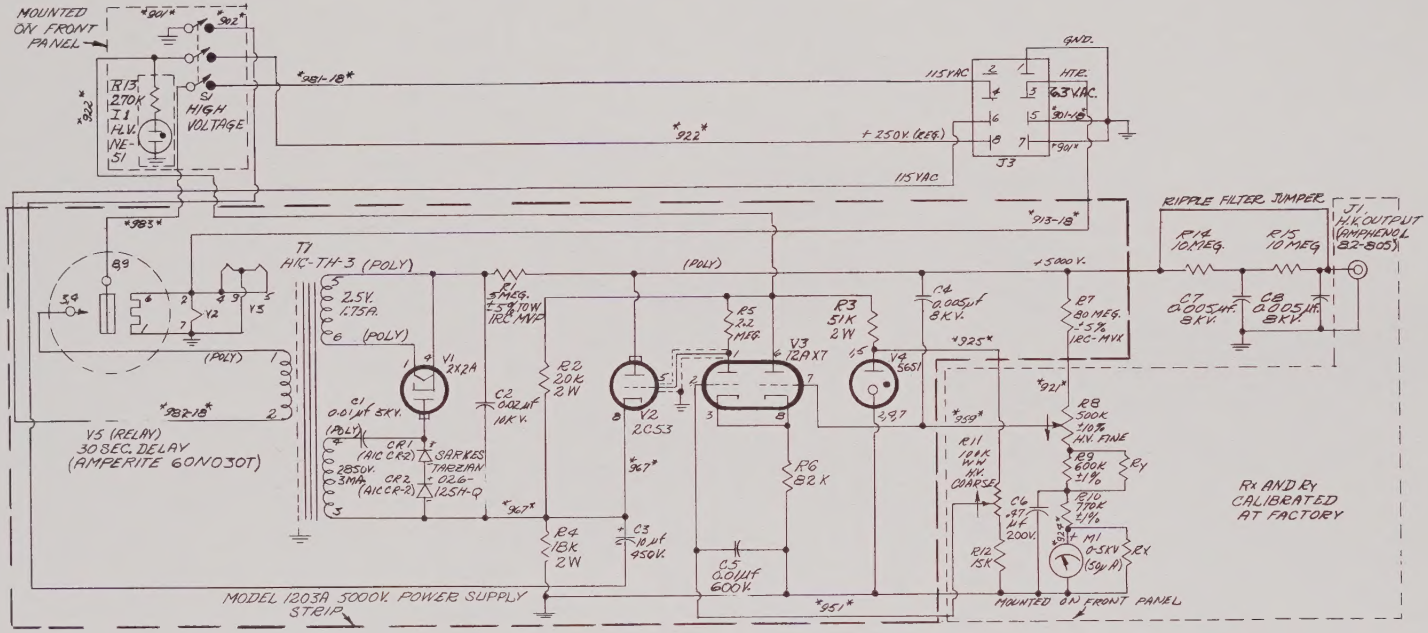
Symbol Designation	Description	B/A Part No.
R15	RESISTOR, 10 meg, 5%, 1/2W, comp.	00196
R16	RESISTOR, 270K, 5%, 1/2W	00298
R101	RESISTOR, 30K, 5%, 5W, wirewound	01308
R102	RESISTOR, 100K, 5%, 1/2W	00319
R103	RESISTOR, 1K, 5%, 1W	00152
Rx	RESISTOR, 1/2W, comp., value determined at factory	
Ry	RESISTOR, 1/2W, comp., value determined at factory	
S1	SWITCH, Rotary, single section, 3PST	01293
S101	SWITCH, DPDT, toggle	01383
T1	TRANSFORMER; primary 117V, 50-60 cycle; secondary 2850V at 3ma, 2.5V at 1.75 amp	01476
T101	TRANSFORMER, power; primary 100-130V, 60 cycle; secondary 600V center-tapped at 50ma, 5V at 2 amp, 6.3V center-tapped at 2.5 amp	01317
V1	TUBE, 2X2A, half-wave high-vacuum rectifier	01295
V2	TUBE, 2053, high-mu triode	01289
V3	TUBE, 12AX7, high-mu twin triode	01478
V4	TUBE, 5651, voltage reference	01723
V5	RELAY, 30 sec. time delay, 6.3VAC	01186
V101	TUBE, 5Y3-GT, full-wave high-vacuum rectifier	01310

*Modifications:

For 50-cycle, 220-volt unit

F101	FUSE, 1/2 amp, 250V, slo-blo	00749
F102	FUSE, 1/2 amp, 250V, slo-blo	00749
T1	TRANSFORMER, high voltage	01481
T101	TRANSFORMER, power	01397

NOTE: R13 IS BUILT IN PILOT LIGHT SOCKET



SCHEMATIC
5000 VOLT POWER SUPPLY
MODEL 309

309-1

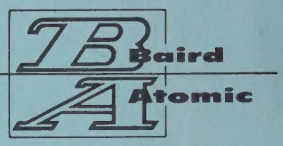
REV. G

Warranty

Baird-Atomic, Inc. (the "Company"), warrants this equipment for a period of 1 year from the date of shipment as follows: it warrants that all equipment of its manufacture is free from defects in material and workmanship at the time of shipment. If within 1 year of shipment any equipment of the Company's manufacture develops defects in material or workmanship under normal conditions of operation, the buyer of the equipment may return it to the Company within 30 days of such failure, for repairs at the expense of the Company excluding transportation costs, or in the case of any defective part may return such part to the Company which will repair or replace the same at its expense excluding transportation costs. A further warranty of 1 year on the same terms shall be applicable to any part so repaired or replaced. Except for Dekatron glow tubes, this warranty does not extend to stock components not manufactured by the Company.

The Company shall not be liable for damage or destruction of instruments during delivery or caused by other than employees of Baird-Atomic, Inc.; in any event, liability shall not exceed the cost of replacement of defective parts upon prompt notification of such defect. For return of equipment or any part thereof under the terms of the foregoing warranty a letter should be forwarded to Baird-Atomic, Inc., Attention: Sales Service Department, 33 University Road, Cambridge 38, Massachusetts. It should state owner's name and address; model and serial number of equipment; the order number under which it was purchased; the date of failure and a description of the circumstances surrounding same. Upon receipt of such information, shipping instructions for return of equipment or parts thereof will be forwarded promptly.

Baird-Atomic, Inc.
33 UNIVERSITY RD., CAMBRIDGE 38, MASS.



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